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OAK RIDGE NATIONAL LABORATORY
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SUBJECT: Radioactive Waste Control and Release at Oak Ridge National Laboratory, X-10 Site, During Calendar Year 1969

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FROM: E. J. Witkowski

LIQUID WASTE

The measurement of radioactive contaminants released to the Clinch River and the monitoring and control of these discharges into White Oak Creek, which carries all liquid waste released from ORNL to the river, may be broken down into three main parts as follows: (1) sampling and measuring the entire discharge to the river at White Oak Dam; (2) monitoring of the creek itself and the various discharges into the creek; and (3) monitoring the process waste system which is the largest single source of contamination discharged to the creek and the most likely source of high activity that could be released to the creek in the event of an accident. The information on liquid wastes presented in this report will be in four sections, one section covering each of the three parts of the operations just mentioned and one section covering our plans for reducing the Laboratory's releases in the future.

Sampling of White Oak Dam Discharges to the Clinch River

The continuous, proportional samples taken at White Oak Dam, Sampling Station 5 (see Figure 1), are the only samples taken of liquid waste streams that are routinely analyzed for all radioactive contaminants. The results of these analyses, which are considered to be the official measurements of the Laboratory's releases into the Clinch River, are published in the Health Physics Division annual reports. The data for the year 1969 are given in Table 1. The values given for alpha releases are based on gross alpha analyses. The alpha contaminant was mainly ^{244}Cm, leaching from the intermediate-level waste trenches that have not been used for waste disposal since 1966.

White Oak Creek Monitoring

Samples taken upstream from the dam, White Oak Creek, the process waste tributaries, the storm sewers, the laundry, and the sanitary sewers are considered to be control samples. The sampling frequency, sampling methods, and analyses made on these control samples are governed by the contaminants found at the dam and the nature of the operations carried on upstream. The reasons for not analyzing for all contaminants, as in the

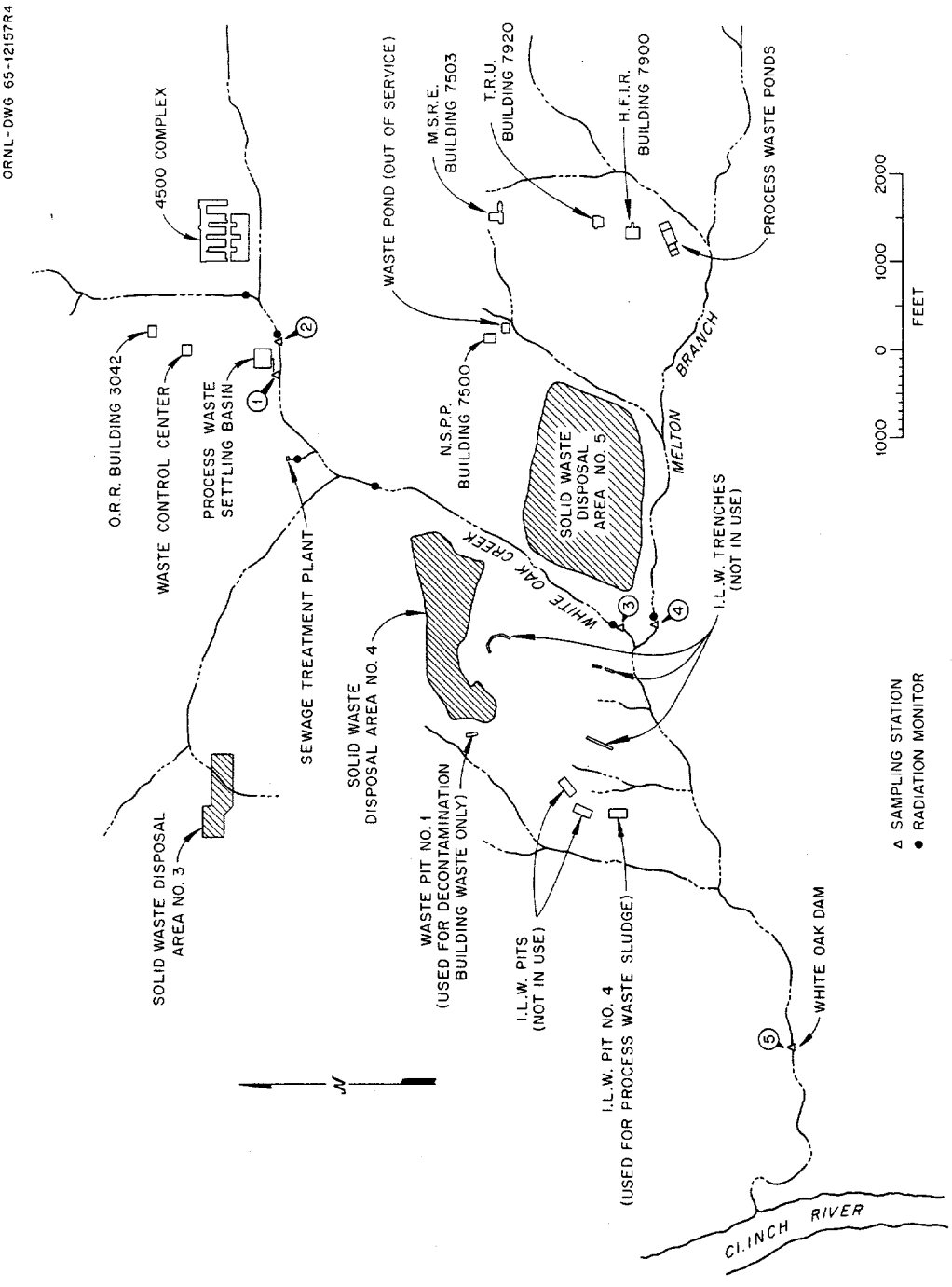


Fig. 1. Location Plan for White Oak Creek Sampling Stations and Radiation Monitors.

Table 1. Radioactive Contaminants Released to Clinch River in 1969

Radioisotope	% MPC_W*	Curies
^{89}Sr	<0.01	0.31
^{90}Sr	0.27	3.1
^{95}Zr, ^{95}Nb	<0.01	0.36
^{144}Ce	<0.01	0.02
^{137}Cs	<0.01	1.4
^{131}I	0.03	0.54
^{140}Ba	<0.01	0.13
^{60}Co	<0.01	1.0
^{106}Ru	<0.01	1.7
^{3}H	0.10	12,247
TRE (-Ce)	<0.01	4.6
Transuranic Alpha	0.0011	0.2
Total	0.41	12,260

*Values given are calculated values based on the concentrations of wastes released from White Oak Dam and the dilution afforded by the Clinch River; they do not include radioactive materials (e.g., fallout) that may enter the river upstream from White Oak Creek.

case of the White Oak Dam samples, is our belief that more complete analyses are not necessary for control purposes and the high cost of radiochemical analyses. The current spending for laboratory analyses, excluding the cost of operating the many stream radiation monitors, is $125,000 per year.

The accounting for releases of ^{90}Sr, ^{3}H, ^{131}I and alpha emitters is considered to be the most important part of waste-monitoring work because of the impact of these isotopes on the environment. The continuous and proportional samples taken from the creek at stations 1, 2, 3, and 4 are routinely analyzed, at least once each month, for $^{89,90}Sr$ and gross alpha. During the first six months of 1969, the samples were also routinely analyzed for ^{60}Co, ^{137}Cs, and $^{103,106}Ru$, but these analyses were discontinued and gross beta analyses were substituted during the last six months of the year. The creek samples were not routinely analyzed for ^{131}I and ^{3}H because their discharge sources were known and their measurements could not alter the total discharge at the dam.

The ^{90}Sr, ^{3}H, ^{131}I and alpha activity releases to the creek, as measured at the creek sampling stations and estimated from grab samples taken from miscellaneous minor sources, are given in Table 2. The locations of these sources are shown in Figures 2 and 3. The discharge of ^{90}Sr from the process waste system was undoubtedly higher than, and possibly twice as high as, the 1.52 curies shown in the table. An exhaustive study of the sampling methods used at the process waste discharge point (Sampling Station 1) revealed in recent months that the equipment and probably the sampling and analytical techniques were faulty and that improvements in these areas resulted in consistently higher discharge figures. The difficulty was caused by the presence of fine precipitates in the stream which carry approximately one-half of the activity discharged. The precipitates tend to settle out in the suction tubing to the sampling pump, the sample containers used to collect monthly composite samples, and the bottles used for delivery of samples to the analytical laboratory so that the material used for analyses was not representative of the waste stream.

The ^{3}H and ^{131}I released to the creek in process waste entered the process-waste system with the intermediate-level waste evaporator

Table 2. Sources of Radioactive Discharges to White Oak Creek in 1969
(Locations of Sources Are Given in Figures 2 and 3)

Source	Curies			Gross Alpha	Sampling Method
	^{90}Sr[a]	^{3}H	^{131}I		
L-1. Process Waste System	1.52[b]	1,200[c]	0.54[c]	None Detected	Continuous, proportional
L-2. Storm Sewer Southwest of Process Waste Treatment Plant	0.20	----	----	----[d]	Periodic grab
L-3. Sanitary Sewage Treatment Plant	0.40	----	----	----[d]	Periodic grab
L-4. Leak into Fifth Street Branch of Creek	0.30	----	----	Trace	Continuous, proportional
L-5. Laundry	Trace	----	----	----[d]	Periodic grab
L-6. Burial Ground No. 4	0.10	----	----	----[d]	Periodic grab
L-7. Burial Ground No. 5 and the Former 7500 Area Waste Pond	0.92	11,000[e]	----	None Detected	Continuous, proportional
L-8. ILW[f] Waste Pits and Trenches (Not used since 1966)	None Detected	<10	----	0.2	Periodic grab

[a] All samples analyzed for total ^{89}Sr and ^{90}Sr. Based on experience, the discharges from sources 1 and 4 were assumed to be 90% ^{90}Sr; all other discharges were assumed to be 100% ^{90}Sr.

[b] Actual discharge may have been as high as 3 curies--see explanation in text.

[c] Estimates based on analyses of samples taken at White Oak Dam and spot checks of process waste discharge.

[d] No alpha activity was detected at creek Sampling Station 3. This station would pick up any significant discharge from this source.

[e] Estimate based on analyses of samples taken at White Oak Dam and spot checks of samples taken at Creek Sampling Station 4.

[f] Intermediate-level waste system.

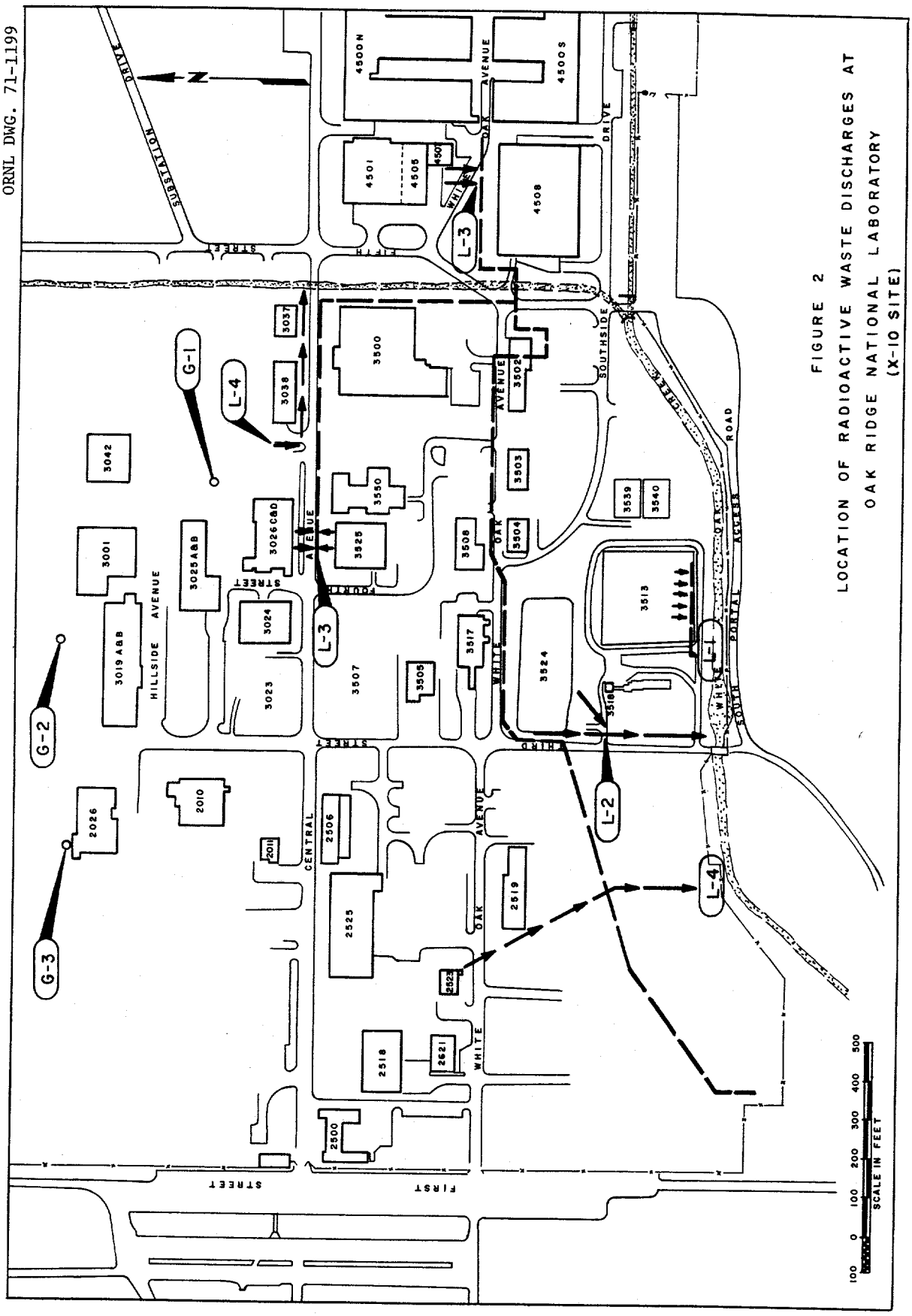
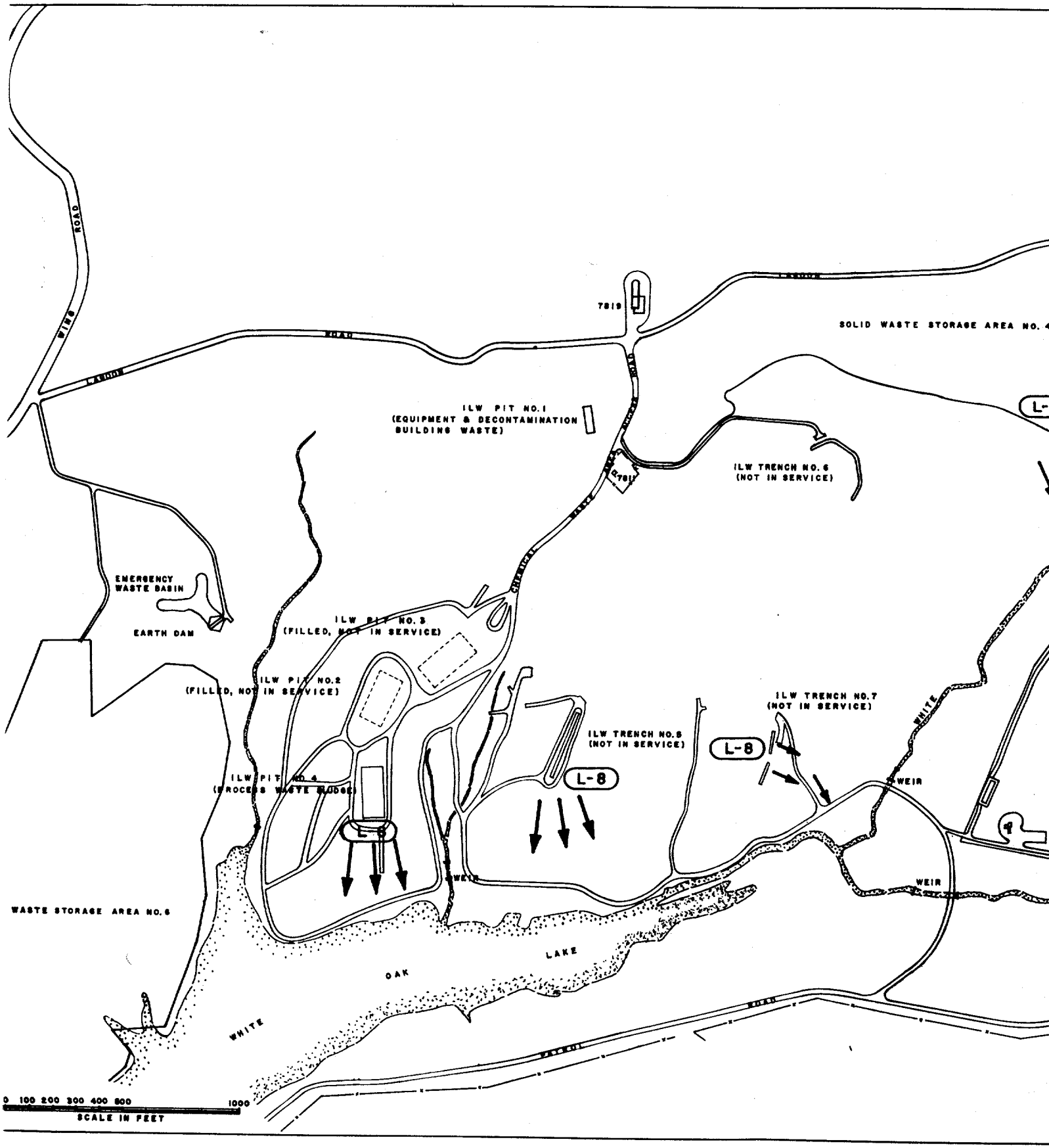


FIGURE 2
LOCATION OF RADIOACTIVE WASTE DISCHARGES AT
OAK RIDGE NATIONAL LABORATORY
(X-10 SITE)


WIRE ROAD
7819
SOLID WASTE STORAGE AREA NO. 4
ILW PIT NO. 1
(EQUIPMENT & DECONTAMINATION BUILDING WASTE)
ILW TRENCH NO. 6
(NOT IN SERVICE)
EMERGENCY WASTE BASIN
EARTH DAM
ILW PIT NO. 3
(FILLED, NOT IN SERVICE)
ILW PIT NO. 2
(FILLED, NOT IN SERVICE)
ILW TRENCH NO. 7
(NOT IN SERVICE)
ILW TRENCH NO. 5
(NOT IN SERVICE)
L-8
WEIR
WASTE STORAGE AREA NO. 6
OAK
LAKE
WHITE
0 100 200 300 400 800 1000
SCALE IN FEET

ORNL DWG.

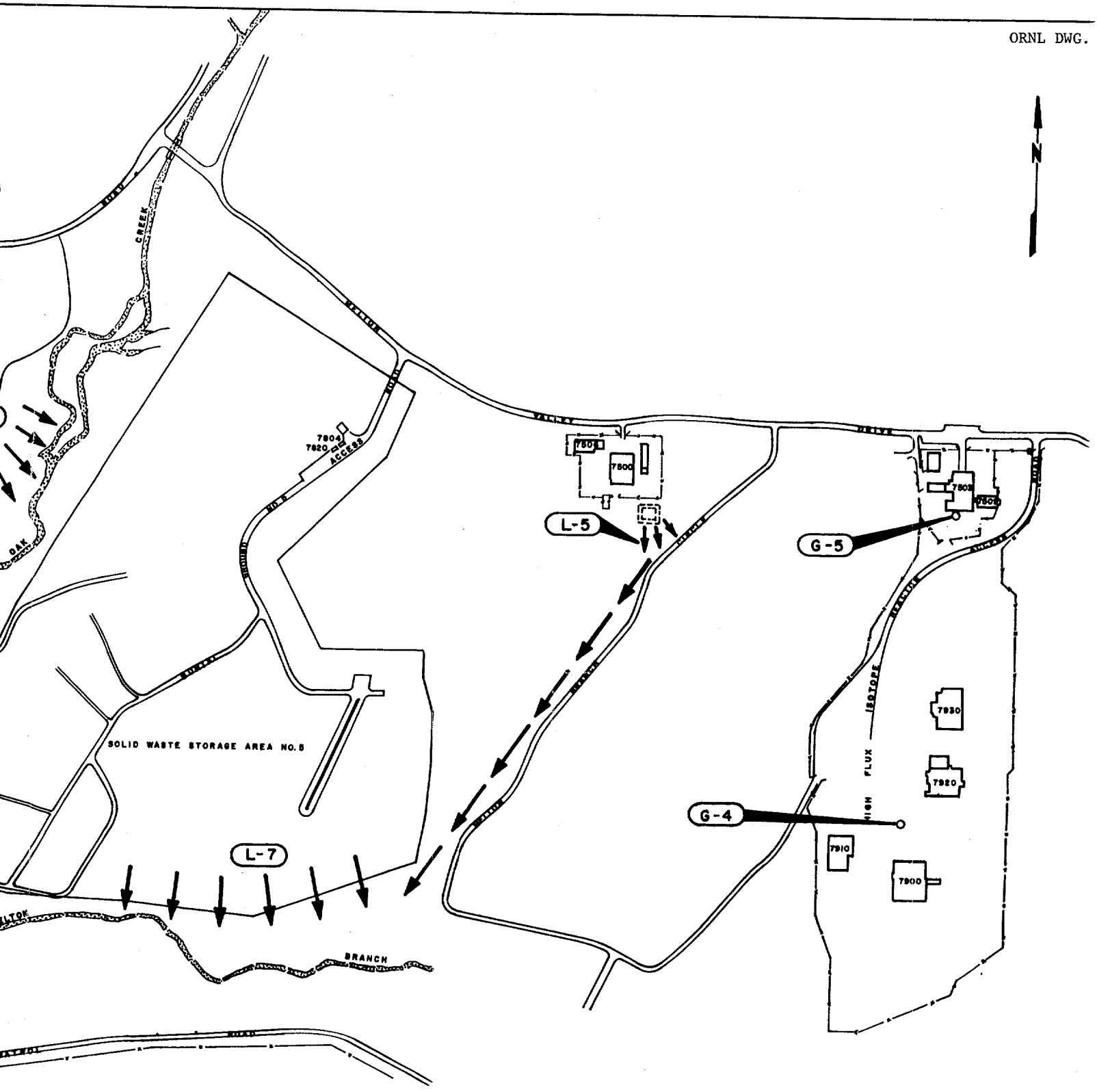


FIGURE 3
LOCATION OF RADIOACTIVE WASTE DISCHARGES AT
OAK RIDGE NATIONAL LABORATORY
(X-10 SITE)

condensate. The ^{3}H originated at the MSRE and the ^{131}I at the transuranium processing plant.

The activity in the storm sewer discharge (Table 2, item L-2) seeped into an abandoned section of clay pipe from contaminated soil around the process waste equalization basin. The activity in the sanitary sewer (item L-3) came mainly from in-leakage under Central Avenue in front of Building 3026, although some traces of activity have also been found in the sewer running east to west on the north side of Building 4508. The leak into the sewer in front of Building 3026 was undoubtedly from earth contaminated by an old intermediate-level waste line that leaked and was taken out of service years ago.

The leak into the Fifth Street branch of the creek (item L-4) is still being investigated. The most recent sampling data obtained indicate that the activity is seeping into a storm sewer running north to south between the Radioisotope and the 3039 Stack areas. This sewer joins the Central Avenue sewer that runs east to the Fifth Street branch of the creek. The activity appears to be seeping into the storm sewer from the soil around waste tank WC-2; this soil was contaminated at one time by a leak from a broken sampler line from that tank.

The release of 0.92 curie of ^{90}Sr from Burial Ground 5 and the 7500 Area (item L-7) was measured at Sampling Station 4; the amount contributed by each source has not been determined. All of the ^{3}H (11,000 curies) seeped into the Melton Branch of the creek from the burial ground where tritium-bearing material from Mound Laboratory is buried.

Process Waste Monitoring

All of the main tributaries of the process waste system are continuously sampled and the samples are analyzed once each month for gross beta and, in some streams, for alpha activity. In addition to the routine monthly analyses, special analyses are run for specific radioisotopes if a significant increase in radioactivity is noted on any of the tributary radiation monitors or at the diversion box where all streams join and if identification of the contaminant is needed to pin-point the source.

As previously mentioned, the analytical data for 1969 show that 1.52 curies of ^{90}Sr were discharged to the creek through the process waste system (see Table 2) but the actual discharge may have been as high as 3 curies. All of the waste released to the creek by this system was processed through the Process Waste Treatment Plant where about three-fourths of the original activity discharged to the system was removed.

The approximate discharges from the various sources into the system, based on gross beta analyses of the tributary streams before treatment, are listed in Table 3. All of the discharges contained mixed fission products including some ^{90}Sr. From these data we estimate that between 50% and 70% of the total radioactivity handled by the process waste system came from soil that was contaminated during the last 27 years of the Laboratory's operation and that most of this contamination came from the sources listed as items 1, 2, 3, and 9. Some portion of the activity attributed to the other five sources may also have seeped into the process waste system piping, although we have no evidence to show that this was the case.

Plans for Reducing Discharges to White Oak Creek

One of the main improvements planned for reducing current radioactive discharges to the creek is the replacement of the existing Process Waste Treatment Plant and its lime-soda ash-clay process with a modified ion-exchange process developed here several years ago. The new plant is budgeted for FY 1972. Its efficiency (based on ^{90}Sr removal) is expected to be near 100%. The present plant efficiency is not more than 80%.

In addition to eliminating practically all of the strontium and most of the other radionuclides that may be released in significant quantities through the process waste system, we are considering the use of the new plant for eliminating the discharges listed in Table 2 as items L-2, L-3, and L-4. We hope to accomplish this by isolating the sections of underground pipe where the contamination is entering the sanitary and storm sewers and pumping the in-leakage into the process waste system. The new plant will not reduce discharges of ^{3}H and will be only partially effective in reducing the ^{131}I discharge. There is no significant amount of ^{3}H

Table 3. Sources of Radioactivity Discharged into the Process Waste System

Source	Curies[a]	Percent of Total	Sampling Method
1. Seep into Pipe under Building 3047	4.1	32.5	Continuous, proportional
2. Radioisotope Area	4.3	34.1	Continuous, proportional
3. Buildings 3503 and 3508	0.75	6.0	Continuous, proportional
4. Buildings 3025 and 3026	0.28	2.2	Continuous, proportional
5. Radiochemical Processing Pilot Plant, Bldg. 3019	0.01	0.1	Continuous, proportional
6. Fission Product Development Laboratory, Bldg. 3517	0.89	7.1	Continuous, proportional
7. Intermediate-Level Waste Evaporator, Building 2531	1.53	12.1	Continuous
8. Buildings 3525 and 3550	0.04	0.3	Continuous, proportional
9. Drainage from Gunite Storage Tank Area	0.70	5.6	Periodic grab
Total	12.6	100.0	

[a]Approximation based on gross beta analyses and an assumed counting efficiency for a mixture of radionuclides normally present in White Oak Creek discharges to the Clinch River.

being handled in the process waste system at the present time, however, so that it is no longer a problem; also, the ^{131}I releases may be controlled at their source by allowing the material to decay in storage.

The new plant for treating process waste will, in addition to reducing current routine discharges to the creek, virtually eliminate the possibility of a major accidental release which could seriously contaminate the Clinch River in excess of the maximum permissible concentration. The present emergency pond, which is supposed to be used in the event of an emergency release, has never been used and its effectiveness in retaining activity, should the need occur, is questionable.

An asphalt cover was recently placed over the area of the former 7500 Area pond to reduce the leaching of ^{90}Sr by rainwater (Table 2, item L-7). How effective this asphalt cover will be in reducing the discharge to the creek is not yet known. We feel that a large portion of the ^{90}Sr measured at creek Sampling Station 4 may be coming from the pond area.

We have no specific plans for reducing the ^{3}H discharge to the river. As previously mentioned, most of the ^{3}H is being leached from Burial Ground 5 where an estimated 60,000 curies were buried. We do not know the accuracy of the estimate since it is based on information given us by Mound Laboratory when Mound Laboratory used our Burial Ground for disposal of its solid wastes. We know of no practical way of removing the many acres of ^{3}H contaminated soil in the Burial Ground and no way to remove the ^{3}H from the many millions of gallons of water contaminated each month by seeps from the Burial Ground. The ^{3}H leached from the Burial Ground in 1970 was 9,000 curies as compared to 11,000 curies in 1969 and the trend appears to be downward. We expect this will cease to be a problem within a few years.

We know of no simple changes in operating and monitoring procedures or inexpensive improvements in equipment which can reduce our current discharges. All possible improvements of this kind that are known to us have already been accomplished. During the next six months, however, we intend to study all phases of the liquid-, gaseous-, and solid-waste operations to determine what improvements are necessary to eliminate all long-term releases of radioactivity to the environment and to prevent the spread of underground contamination at ORNL. This study will include: (1) an assessment of the problem of underground contamination caused by burial of solid

waste and underground leaks of liquid waste lines; (2) an investigation to determine the need for the many underground waste lines that are now in use and the possibility of taking some of the lines that may be leaking out of service; and (3) a determination of the condition of the underground waste tanks and the transfer lines and the need for their replacement.

GASEOUS WASTE

The releases of radioactive material in gases from the five operating stacks (see Figures 2 and 3) in 1969 are given in Table 4. The only radionuclides measured in significant quantities were ^{131}I, Xe, and Kr. There were no significant releases of alpha or particulate activities.

The measurement of ^{131}I and particulate activity and scans for other activities were made on samples of gases taken on charcoal and filter paper cartridges. The sampling of the stack gases was continuous and the frequency of analyses is shown in Table 4. The iodine release for the year was ∿34% of that permitted under present operating rules. The limit of 50 curies is based upon typical meteorological conditions and an MPC of 1.4×10^{-13} μc/cc, which is a factor of 700 lower than that set forth in 10 CFR, Part 20.

The maximum possible release of noble gases were estimated from continuous, direct radiation measurements made on sample streams withdrawn from the stacks through sample chambers that had been laboratory calibrated with known quantities of ^{133}Xe and ^{85}Kr. The releases listed in Table 4 were <1.3% of the maximum permitted under present ORNL operating rules. The amount permitted is that which would produce nonoccupational MPC values (10 CFR, Part 20) on and beyond the site boundary.

Practically all of the ^{131}I released from the 3039 Stack, as shown in Table 4, came from fission product separation in the Radioisotope Processing Area and waste tank WC-2 serving that area. The Xe and Kr released from this this stack also appear to have come from fission product separation processes but there is some doubt about the operations responsible for the discharges. The discharges from the 7911 Stack came from the Transuranium Processing Plant, Building 7920.

Table 4. Radioactive Gas Release from ORNL Stacks in 1969

Release Point	^{131}I Curies	^{131}I Frequency of Analyses	Xe and Kr Curies
G-1. Central Gas Disposal Facility, Stack 3039	9.0	3 Times Each Week	<92,000[a]
G-2. Radiochemical Processing Pilot Plant, Stack 3020	0.03	Weekly	---
G-3. HRLAL, Stack 2026	6.4	Weekly	---
G-4. HFIR, TRU, Stack 7911	0.70	Weekly (Daily when TRU is in Operation)	<12,000[a]
G-5. MSRE, Stack 7512	0.80	Weekly	---
Total	16.9		<104,000[a]

[a]Estimated maximum amount based on continuous sample stream radiation measurements. The actual release may have been several times lower (see explanation in text).

In addition to the discharges given in Table 4, we estimate that less than 150 curies of ^{3}H were released into the atmosphere from ORNL operations. The two sources that accounted for practically the entire discharge were the tritium packaging operation in the Radioisotope Processing Area and the Tritium Target Fabrication Building (7025).

In addition to the stack monitoring and sampling that is done to obtain data as given in Table 4, all of the stacks and main tributaries are continuously monitored by radiation-detection instruments for releases of ^{131}I, beta-gamma particles, and alpha activities. The monitoring information from all stacks is transmitted and recorded at a central waste monitoring center where an operator is stationed around-the-clock to follow up any irregularity that may be noted in gaseous- and liquid-waste streams.

Plans for Reducing Future Discharges

The total release of ^{131}I in 1970 was less than 10% of that shown in Table 4 for 1969. The release from HRLAL, Stack 2026, was eliminated entirely when analytical work on samples from the MSRE was discontinued. To prevent future releases from this stack, charcoal filters are being installed in the analytical cell-ventilation system. The installation will be completed in the spring of 1971. The ^{131}I discharge from the 3039 Stack was also reduced (from 9.0 curies in 1969 to 1.0 curie in 1970) by the installation of charcoal filters in the off-gas line from the waste tank serving the Radioisotope Area and by minor changes in the fission product separation processes.

The only other improvement planned at present, besides the complete survey of all of the waste-disposal practices previously mentioned in the section on liquid waste, is the installation of a 100,000 cfm emergency-standby cell-ventilation fan at the 3039 Stack. This fan will reduce the possibility of accidental releases of activity into the atmosphere during periods of power outage but will not reduce the routine releases as given in Table 4.